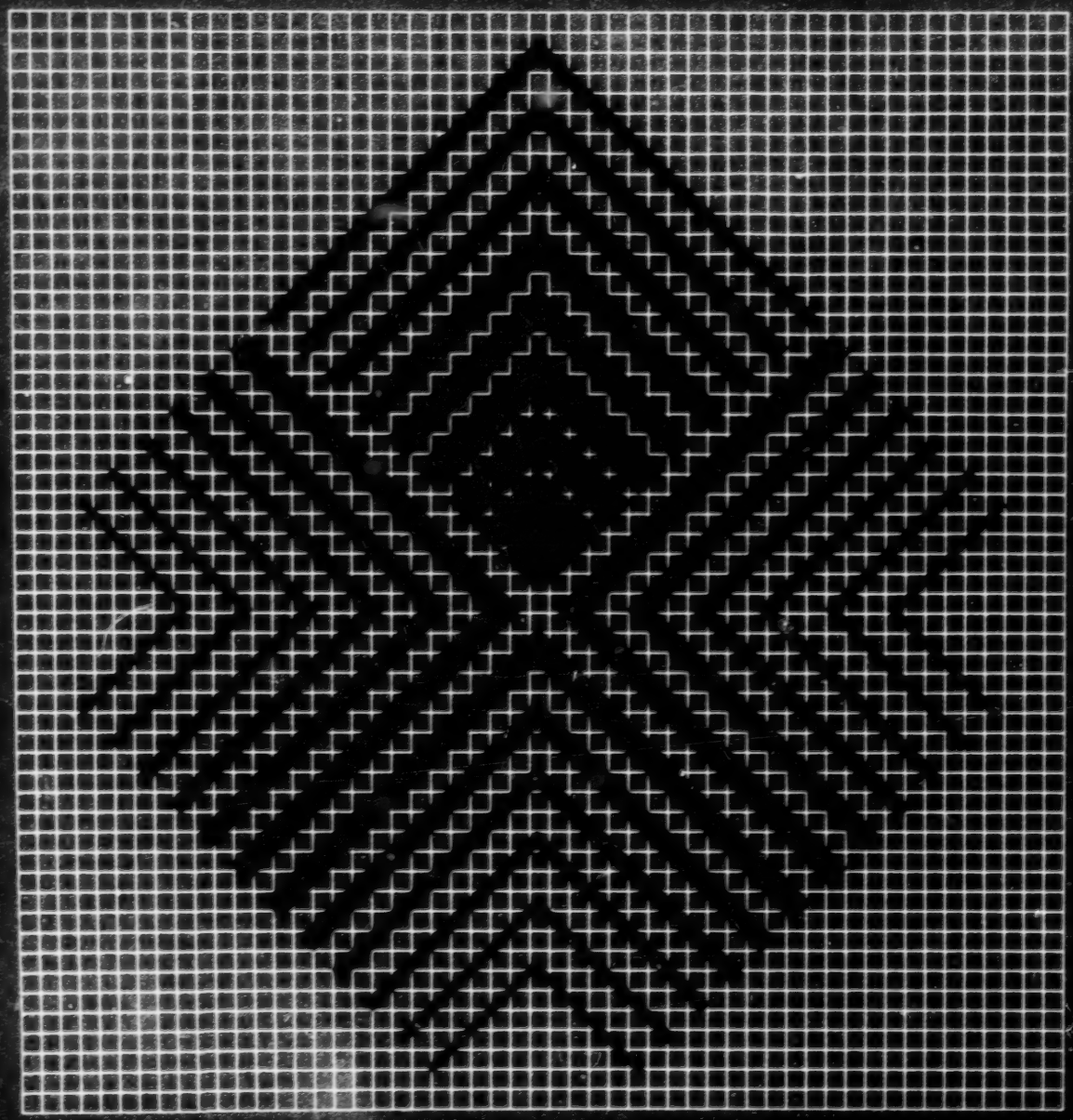
THE IMPACT OF MICROCHIP TECHNOLOGY ON EDP MANPOWER DEMAND



THE IMPACT OF MICROCHIP TECHNOLOGY ON EDP MANPOWER DEMAND

ONTARIO MANPOWER COMMISSION
MINISTRY OF LABOUR
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HIGHLIGHTS

Thorne Stevenson & Kellogg was commissioned by the Ontario Manpower Commission to provide a qualitative assessment of the changing demand for computer services personnel. This changing demand is anticipated to be dramatic in the next few years as a result of the influence of microchip technology. This study was conducted as one component of a larger microchip impact assessment which was undertaken by the OMC.

In addition to this study, the Commission also carried out a number of other studies at the request of the Ontario Task Force on Microelectronics. The purpose of these studies was to develop information on future manpower requirements and supplies for selected technical and professional occupations in the microelectronics industry over the 1981-1985 period. A report summarizing the findings of these studies, including the preliminary results of the survey presented in this report, was released by the Ontario Task Force on Microelectronics in November 1981. The summary report, entitled Professional and Technical Manpower Requirements and Supplies in the Microelectronics Industry in Ontario: 1981-1985 is available from the Ontario Manpower Commission.

This particular study employed a Delphi-type* technique of inquiry. The "Delphi" approach was used here for a number of reasons, the most important one being its unique capability of pooling and evaluating various expert-opinions regarding potential changes resulting from developments for which there are no clear precedents.

Expert opinion was provided by 29 respondents to the questionnaire. Their responses are summarized briefly below.

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*For a detailed description of the Delphi-type process followed in this study, see Chapter 1, pages 1 and 2 of this report.

1. Experts anticipated an increase in demand for most computer professionals by 1986, in most cases up to twice the present demand.

2. The major reason offered for support of a greater total professional demand was that, as a result of microchip technology, low cost systems will proliferate dramatically. Such explosive growth will create short-term decentralization, requiring more customized systems and local personnel.

3. The expectation for the greatest increase in demand was for an emerging professional type with dual capabilities — a functional specialist with computer knowledge. This person would spend a significant portion of time operating a computer or terminal to process or retrieve infomation in support of his/her professional speciality.

4. The only traditional computer-related professional for which a decline in demand was expected is the data entry/control clerk.

5. A number of additional types of computer professionals were anticipated to grow in demand. These types included communications personnel, interface analysts, security specialists and EDP consultants.

6. The future demand for professionals to support process control and word processing systems was not agreed upon by the experts. About half the respondents supported the position that very few such personnel would be needed. Others suggested that as the future complexity of such devices was unknown, the demand for support personnel was difficult to predict.

CHAPTER I

INTRODUCTION AND METHODOLOGY

As part of a larger study on the manpower impact of microchip technology, the Ontario Manpower Commission initiated a survey of computer users. The purpose of that survey was to assess future manpower requirements for computer personnel, by extrapolation of individual companies' requirements.

This approach, however, was deemed to contain certain risks. The major concern was that such an extrapolation typically projects forward existing, traditional types of personnel. It may not focus on emerging technology which can have a major impact on the changing mix of personnel needed. Also, the approach may overlook new types or categories of personnel that may be needed.

Consequently, it was important that a brief analysis be undertaken which could investigate more thoroughly such potentially important future changes in computer personnel demand.

Thorne Stevenson & Kellogg agreed that a Delphi-type approach would be an appropriate way to study such changes in future personnel demand. Questionnaires would be sent to a group of industry experts who would respond to statements contained therein, and support their answers. Such an approach would have several advantages. It would :

- Allow for anonymous opinion;
- Capture independent opinion;
- Offer freedom from group influence;
- Capture expectations of change which are non-extrapolative—for which there is no precedent;
- Provide for considered response which is not time constrained;
- Allow for opinion change, if necessary.

Early in the study, a panel discussion with six experts in the computer industry was held in the Thorne Stevenson & Kellogg offices. The purpose of this discussion was to resolve the issues which should be focused upon, and the way the questions should be positioned. A questionnaire was developed from this discussion, reviewed with the Commission and pre-tested. This questionnaire is shown in Appendix B.

The questionnaire was then sent to 36 industry experts for their opinion. A list of those experts is provided in Appendix C. There were 29 respondents, a number sufficiently large to be representative of general expert opinion. Moreover, most of the few panelists who did not respond acknowledged that they did not reply because of timing problems. They simply were not able to return their answers during the short time period allowed. It is not felt, therefore, that non-respondent bias could have been material to the results of this study.

One of the features of the Delphi approach is that it provides for additional rounds of questionnaires. These subsequent rounds use first round aggregate responses as information to panelists, allowing them to modify their original responses in light of group opinion. Such additional rounds are particularly useful where there is little or no consensus on first round issues.

In the opinion of Thorne Stevenson & Kellogg, the findings from the first round indicated good consensus on the major issues. They did not believe that there would be a significant enough improvement in the quality of the findings to merit a second round.

CHAPTER II

FINDINGS

The questionnaire which was sent out to panelists was designed to progress in a logical way through a number of specific issues. It was desirable to assess panelists' reasons for their forecasts about the future requirements for data processing personnel. Had inquiries focussed only on future demand without any investigation of background issues, it would have been difficult to generalize about the opinions expressed. Even if there had been consensus on issues, any commentary on the basis and the reliability of the forecasts would have been difficult.

The questionnaire began, therefore, by discussing two major areas influenced by microchip technology: process control and word processing. Both of these areas are expected to exhibit major growth throughout the next decade. It then inquired about some situations relating to traditional data processing. Finally, overall predictions about the demand for computer personnel were elicited.

A. PROCESS CONTROL AND WORD PROCESSING

1. Design and development personnel

The first questions presented to the panelists are given below:

"There undoubtedly will be a significant requirement for system design and development personnel (both hardware and software) in the areas of process control and word processing. Opinion has been expressed, however, that most of that effort will be technically sophisticated, will largely be concentrated at the manufacturer level, and will not evolve into a major manpower requirement.

Do you basically agree with the opinion in the above paragraph? (Check one): ____ Yes ____ No. If you checked "No", please indicate why:"

There was more agreement than disagreement with the paragraph, as shown in Appendix A, Exhibit 1.

The major reason given for disagreement with the paragraph was that the next five years are going to show enormous growth in the areas cited. It perhaps is naive to assume that this growth will all be well co-ordinated and centralized in the established companies. Such explosive growth likely will spawn a large number of new companies, each of which will be developing and designing hardware and software. Each will need its own cadre of design personnel. Consequently, there could be a significant increase in demand for such people in the next five years, until the industry rationalizes.

2. Analysts and programmers

The second question presented to the panelists is shown below.

"Sophisticated process control systems in robotics applications will require some numerical control changes when the system is moved from one application to another. However, these numerical control operations probably will require only simple re-direction of mechanical movements, not computer services personnel such as programmers or analysts.

Do you basically agree with the statements made in the above paragraph? (Check one) ____ Yes ____ No. If you checked "No", please state why:"

Again, there was more agreement than disagreement with the statement. Responses are shown in Appendix A, Exhibit II.

The principal reason given for disagreement was that it is possible that future robotics systems will be considerably more sophisticated than present ones. Such complex systems may, in fact, require complex systems analysis similar to that required for computers. Thorough sytems design will be necessary in order to optimize the total industrial operation.

The second most frequent reason given for not accepting the statement is that too little is known about the future sophistication of process control systems.

Respondents chose to disagree, rather than to agree with a statement that they could not judge. In fact, two panelists did not respond at all to the question.

3. All computer personnel

The third question presented to panelists is shown below:

"We therefore suggest that there will be relatively little demand for traditional computer personnel in the process control and word processing functional areas, with the exception of personnel in the data entry and data control areas.

Do you basically agree with the statement in the above paragraph? (Check one) ____ Yes ____ No. If you checked "No", please indicate why:"

Responses to this question are provided in Appendix A, Exhibit III. As shown, opinion was almost evenly split, with one more respondent disagreeing than agreeing.

Most of the dissenting opinion was similar to that given to the first question. It is simply not realistic to presume that an area of massive new growth will not carry with it a major complement of professionals and technicians.

The personnel required will be varied. They will include hardware and software designers, and a large number of applications experts, similar to systems analysts, who will determine exactly what the systems should do, and how they should perform.

B. TRADITIONAL DATA PROCESSING

The fourth question presented to panelists asked them to rank-order their estimate of the likelihood of the occurrence of each of three scenarios. These scenarios described situations in which varying demands might be made for traditional computer analysts and programmers, as shown below.

A. Because of the number of pre-programmed packages available in the future, the total demand for full-time programmers and analysts will decrease.

B. As micro and mini computers become more commonplace, analysts and programmers will more and more decentralize, moving to user locations. The total demand for these professionals will not change, just their location.

C. Other opinion suggest that as users become more accustomed to obtaining low-cost information, appetites for even more information will grow. This situation will result in an increase in the total demand for full-time computer professionals.

The results are shown graphically in Appendix A, Exhibit IV. There is obviously good consensus among the respondents who believe there will be a greater total demand for analysts and programmers by 1986. Almost 86% of the respondents suggested that the situation describing the need for more such professionals would be the "most likely". The same percentage also stated that a smaller demand for those professionals was the "least likely".

The reason most commonly given for this increase in demand was that the reduction in computing cost resulting from microchip technology would lead to more applications. Along with this increase in applications there would be more personnel — at least in the short term, and 1986 is considered to be within the short term.

There were a number of reasons given as support for the comment noted above. Some of these supporting reasons, in order of frequency mentioned (most popular listed first), are shown below:

- History has shown that as a new technology develops, the personnel requirements to support technology outstrip the labour savings resulting from that technology;

- Most of the pre-packaged programs will need modification to meet a company's particular needs;

- In-house systems have a limited life: they need to be constantly modified or replaced;

- As the technology becomes more "friendly" there will be an increase in the number of applications professionals such as systems analysts.

- Although conventional wisdom might suggest we already should be showing a decline in professional demand, there are more unfilled vacancies than before.

C. FUNCTIONAL SPECIALISTS/COMPUTER OPERATORS

The fifth question asked panelists about the likelihood of a new type of computer personnel in the future. The question was stated as follows:

> "One possible consequence of microchip technology is that not only may the number and mix of computer professionals change, but also the types of computer personnel may be affected. Functional specialists such as accountants or business analysts who spend some time in their functional speciality, and some time modifying and running applications software, or "firmware", may become commonplace.
>
> Do you agree with the statements made in the above paragraph? (Check one) _____ Yes _____ No. If you checked "No", please state why:"

Response to this question is shown in Appendix A, Exhibit V. Agreement with the paragraph as written was almost total. Obviously respondents were generally convinced that there will be major future opportunity for functional professionals who also operate a computer or local terminal, withdrawing information from it first-hand.

There was not much comment on this question because agreement was so strong. Major reasons given for disagreement were:

- Unless considerable better computer training is given to functional specialists than at present, the situation as described will not occur;

- It is not the main interest of hardware manufacturers to improve their software substantially. Computers may not be as user-friendly in the short term as everyone believes.

D. ALL COMPUTER PROFESSIONALS

The next question asked panelists to indicate their expectations of future demand for seven types of computer personnel. They were requested to pick one level of demand for each personnel type, according to the following guide:

"Far Fewer".....Less than half as many

"Fewer".....Down to half as many

"The Same".....About the same number

"More".....Up to twice as many

"Far More".....Over twice as many

Results of their responses are shown graphically in Appendix A, Exhibits VI through VIII.

It is apparent from a brief look at the histograms that respondents believed there will be more demand for most types of computer personnel. The only exception was for "Data Entry/Control Clerks", for which respondents believed there will be demand for fewer.

The most frequent, or modal response for systems analysts, programmers, software programmers, computer operators and hardware maintenance personnel was that there would be a demand for "More" of each of these types.

In Appendix A, Exhibit IX shows some statistical measures of the responses, including the mode, the median, and the interquartile range. In order to make the calculations shown in Appendix A, Exhibit IX, an arbitrary value was given to each response, from 1 to 5, corresponding to "Far Fewer" through "Far More".

Analysis of Appendix A, Exhibit IX indicates that there was also general belief that there would be a significantly greater demand for "Functional Specialists/ Operators", with a modal value of "5" meaning "Far More". Additionally, the modal response for "Data Entry/Control Clerks" was that there will be demand for "Fewer".

An examination of the median responses adds some further insight. The median responses, which are perhaps more meaningful values than the mode, as it represents the central position, are close to the modal value for "Systems Analysts" and "Programmers". However, for most of the other categories the median is a less extreme value compared to the mode. In fact, for computer operators and maintenance personnel the median value is close to the boundary between "Same" and "More". Also, there may not be quite as large a demand for "Functional Specialists/Operators" or as slight a demand for "Data Entry/Control Clerks" as might be suggested from the modal value alone.

The Interquartile Range is the standard measure of "central tendency" where the underlying distribution is unknown. Examination of this statistic shows that there was much stronger consensus among respondents for the "Systems Analysts" and "Programmers" categories than for most of the other personnel types. This narrower range for analysts and programmers reflects the fact that the future roles of those personnel were more clearly agreed upon, and possibly understood, than the other types.

E. EMERGING PERSONNEL TYPES

The final question asked panelists to comment on expected increased demand for any future personnel types which had not been noted before. In descending order of frequency, responses are shown below:

- Telecommunications network personnel;
- Interface managers and analysts;
- Security specialists and EDP auditors, because of the proliferation of data banks and easy access;

- Consulting professionals, advising on the large array of possible configurations;

- EDP teachers;

- Personnel whose nature can barely be perceived at this time.

CHAPTER III

CONCLUSIONS

Based upon the findings documented in the previous chapter, a number of conclusions have been derived. These conclusions are based upon responses received, and reflect what the respondents thought would happen.

1. Most experts anticipated that there will be an overall increase in demand for most computer professionals by 1986.

2. There was a generally-held opinion that low-cost computing will lead to the proliferation of computers and computer-controlled systems. That situation in turn will spawn an industry demand for more professionals, which will not abate by 1986.

3. Respondents believed that there is a high probability that there will be a demand for more — up to twice as many — systems analysts and programmers by 1986.

4. There was also strong expectation that an emerging type of computer professional will become commonplace. This professional type will be a functional specialist who also spends a significant portion of his time with a computer. The number of these types, compared to the present, could be well over double.

5. It was generally believed that other computer professionals — software programmers, operators, maintenance personnel — will increase somewhat. Opinion suggests the demand will lie somewhere above current demand, but not likely as much as double the present requirement.

6. It was generally thought that demand will decline a little (but not as much as half) for data entry and data control clerks.

7. There was a fairly consistent opinion that there will be a number of new types of personnel on the scene by 1986. Some of these include communications personnel, interface analysts, security specialists and EDP consultants.

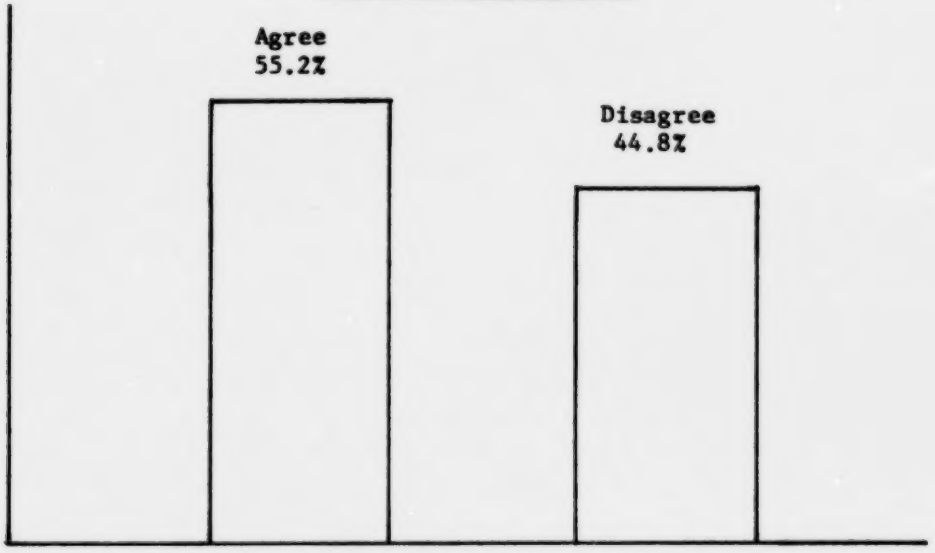
8. There was no clear agreement about the future capability and sophistication of word processing and process control devices. Consequently, among many experts there was some uncertainty about the future personnel requirements for those devices.

APPENDIX A

EXHIBITS

EXHIBIT I

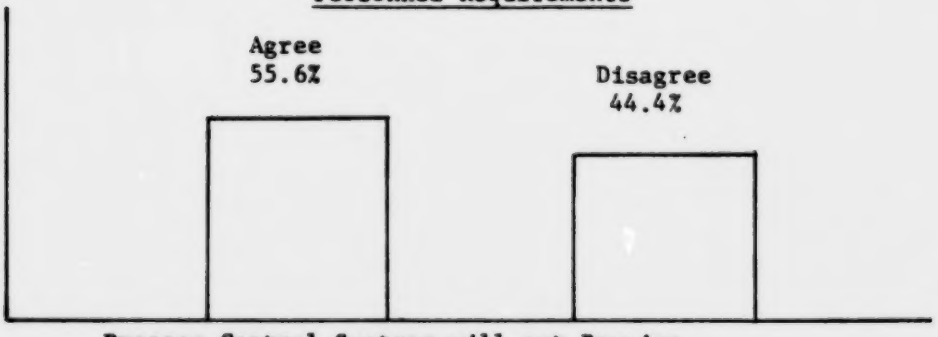
Personnel Requirements



No Major Requirement for Design and Development Personnel in Process Control and Word Processing

EXHIBIT II

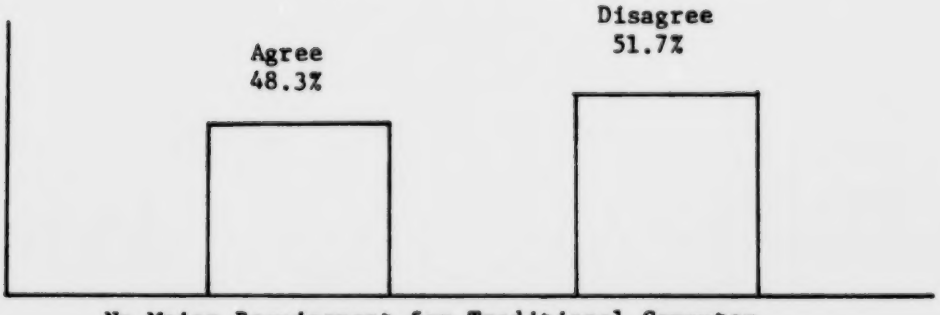
Personnel Requirements



Process Control Systems will not Require Programmers and Analysts

EXHIBIT III

Personnel Requirements

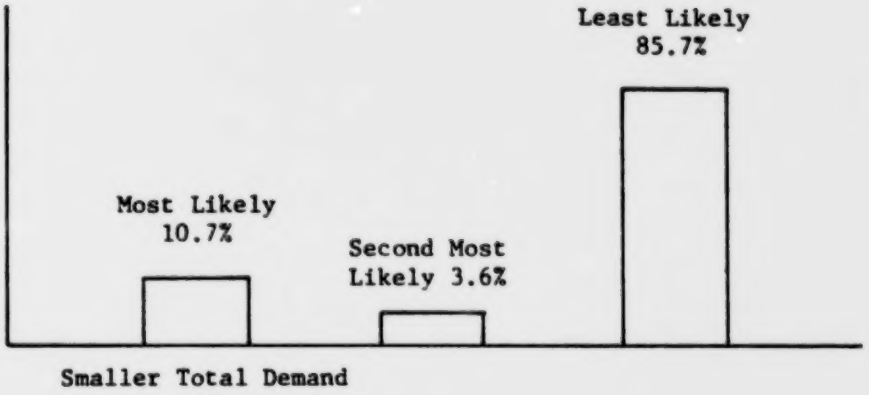


No Major Requirement for Traditional Computer Personnel in Process Control and Word Processing

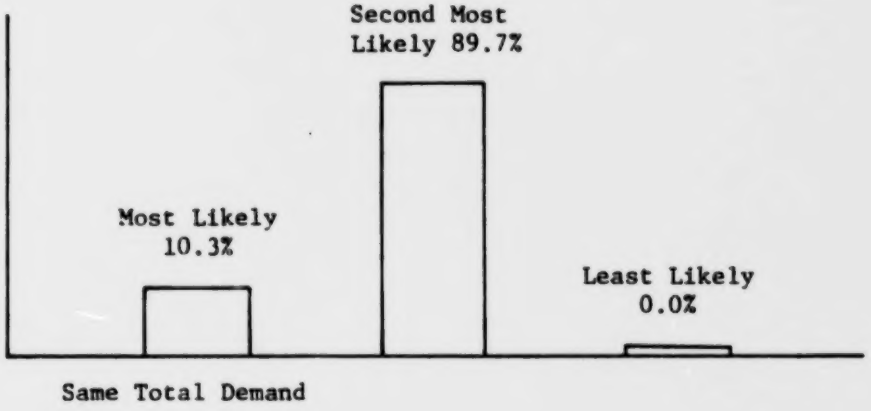
EXHIBIT IV

Ranking of Expected Total Demand
For Full-Time Programmers and Analysts

A



B



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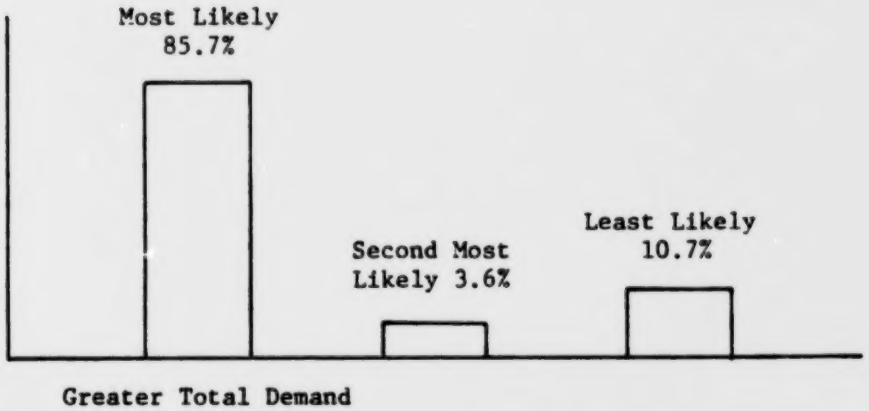
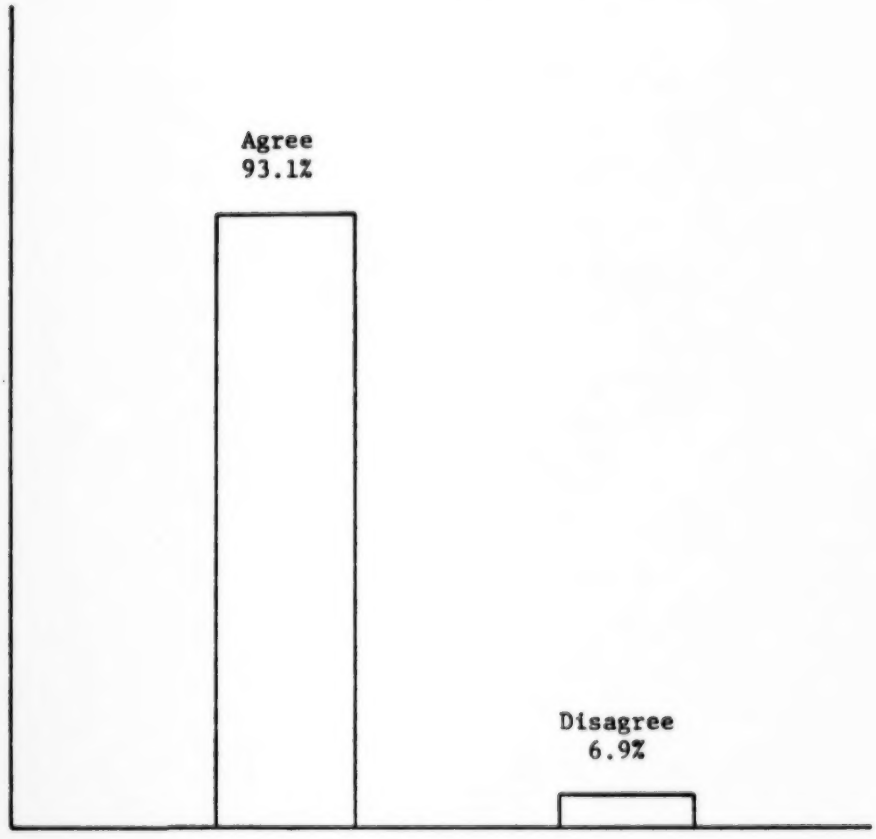


EXHIBIT V

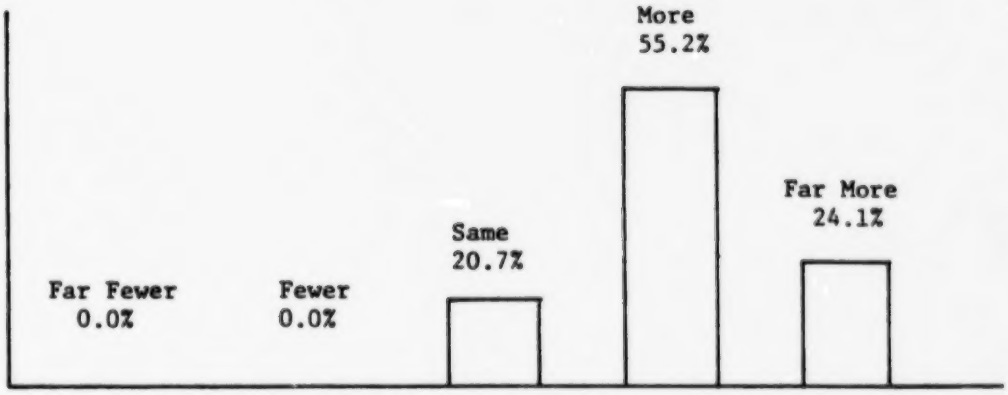
Dual-role Professionals



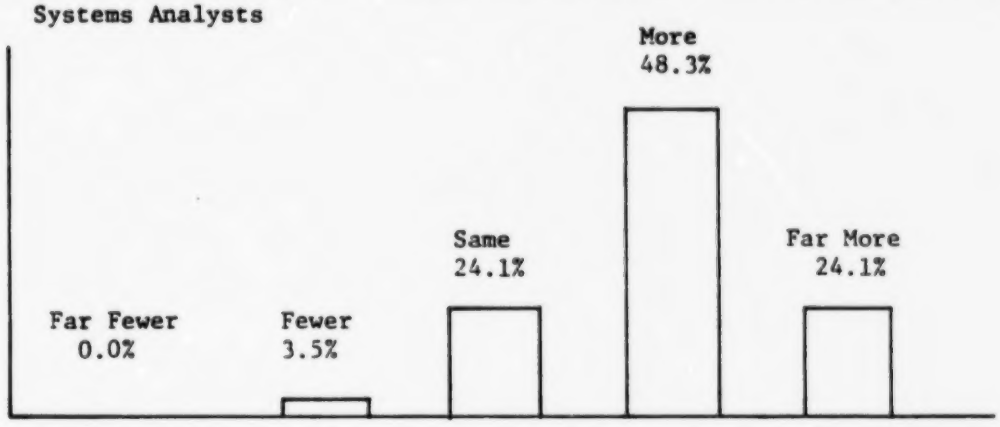
New Dual-role Professional will emerge:
Functional Specialist/Computer Operator

EXHIBIT VI

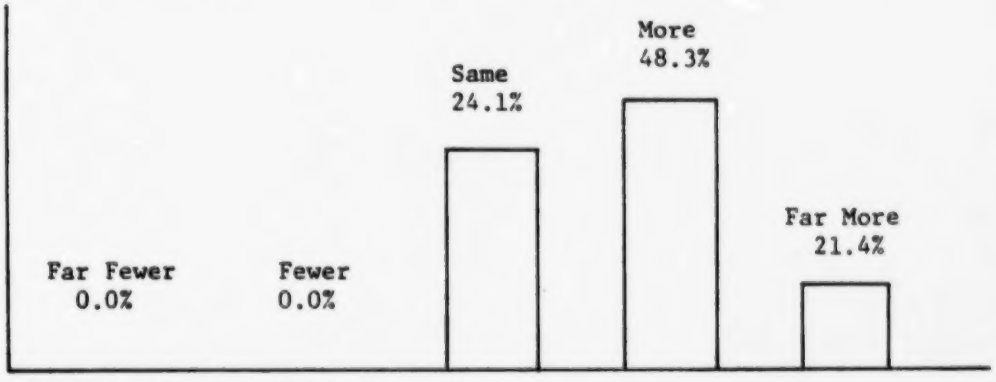
Estimates of Relative Demand for Number of Computer Professionals in 1986



Systems Analysts



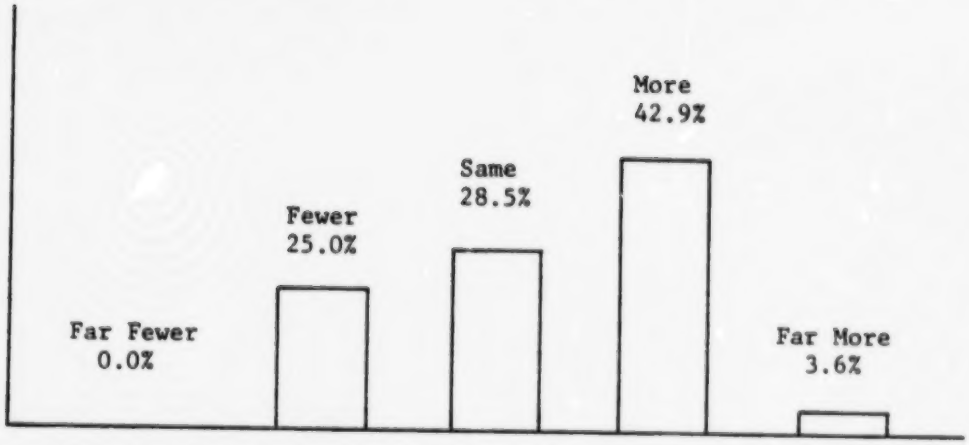
Programmers



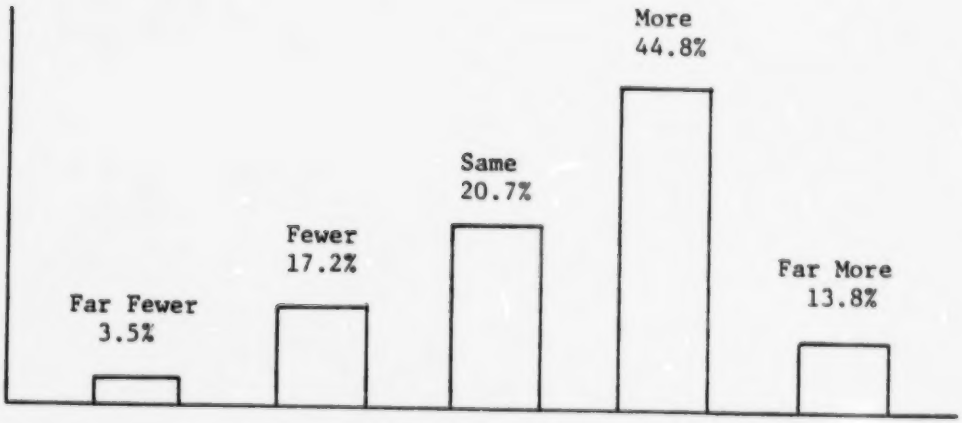
Software Programmers

EXHIBIT VII

Estimates of Relative Demand for Number of Computer Professionals in 1986



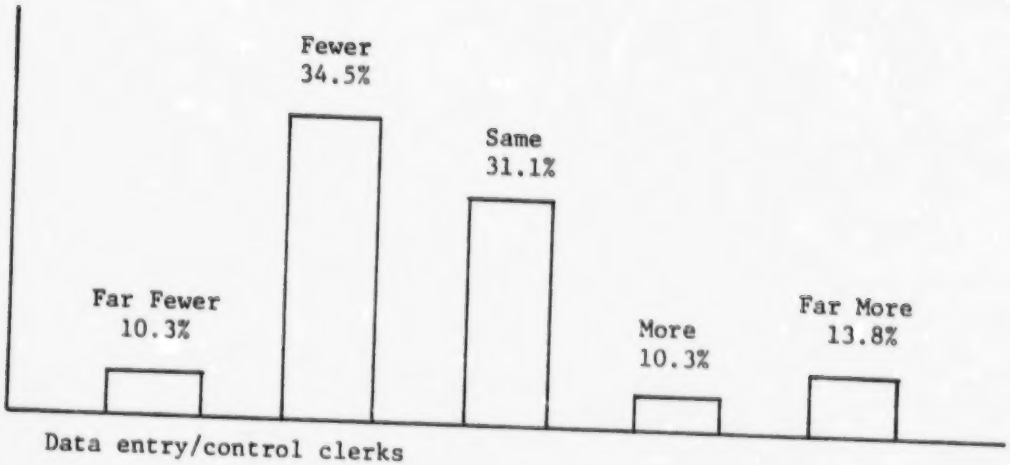
Computer Operators



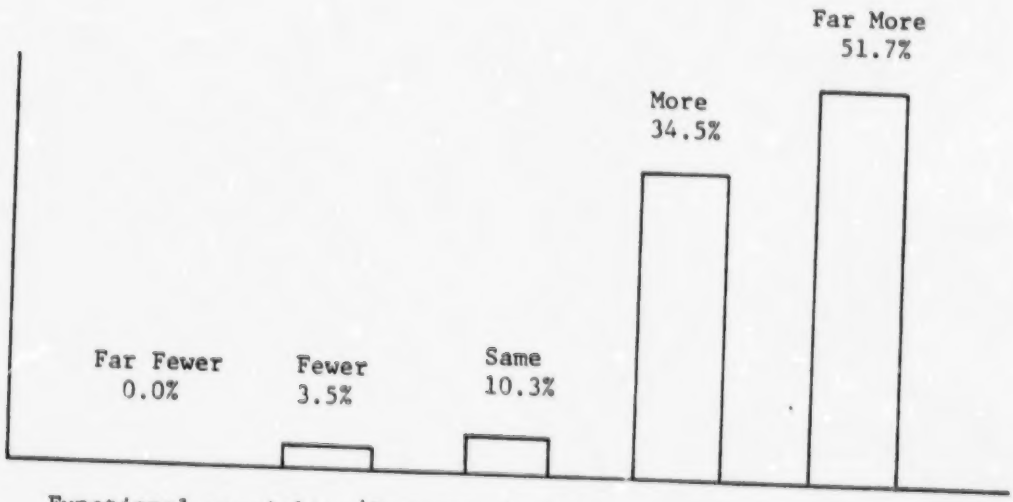
Maintenance (hardware) personnel

EXHIBIT VIII

Estimates of Relative Demand for Number of Computer Professionals in 1986



Data entry/control clerks



Functional specialist/Computer Operator

EXHIBIT IX **Statistical Evaluation of Responses**

	Mode	Interquartile Median 1	Range 2
Systems Analysts	4	4.03	.91
Programmers	4	3.96	1.03
Software Programmers	4	3.83	1.22
Computer Operators	4	3.43	1.50
Functional Specialists/Operators	5	4.53	1.19
Maintenance Personnel	4	3.69	1.54
Data Entry/ Control Clerks	2	2.67	1.54

1. The Median is the middle value, or the point above which and below which there are an equal number of responses. The calculation assumes a continuum of responses in each category; e.g., the 16 responses for "More" Systems Analysts (Exhibit IV-4) assumes an even distribution from 3.5 to 4.5.

2. The Interquartile Range is the spread around the Median which includes 50% of the responses — 25% on either side of the Median.

APPENDIX B

MICROCHIP TECHNOLOGY

QUESTIONNAIRE

STUDY OF THE IMPACT

OF MICROCHIP TECHNOLOGY

ON REQUIREMENTS FOR

COMPUTER SERVICES PERSONNEL

YOUR NAME: _____

ORGANIZATION: _____

STUDY OF REQUIREMENTS

FOR COMPUTER SERVICES PERSONNEL

Below is a brief background of some factors affecting the demand for personnel in the computer services field, relating to microchip technology. A number of assumptions are contained in this background. We would appreciate any comments you may have on any of these issues as you read through them.

The purpose of this questionnaire is to obtain your estimates of the changing requirements for computer services personnel five years from now. Computer services personnel are intended to include persons involved in design and development, feasibility and selection, system operations, maintenance, and information management.

There are a number of new directions into which computers are expected to make rapid advances in the future, largely as a result of reliable, low-cost systems made available through microchip technology. Some of these are itemized below:

- in industry,
- in the office,
- in the home,
- in medicine,
- in education.

The major functional areas of computer growth in the future can be divided as shown below:

- process control;
- word processing;
- data processing.

By process control, we mean the full range of automated systems, including those below:

- robotics;
- instrument record and feedback;
- industrial control.

By word processing, we mean the total system, (e.g., office of the future, computers in the home) including:

- file handling capability;
- message storage and switching;
- interactive mode of operation;
- communications linkages;
- video display capability.

By data processing, we mean the generalized, stand-alone digital processing system with human -readable output, often in a hard copy.

Based on these definitions, we mention below some possible future scenarios for your comments.

There undoubtedly will be a significant requirement for system design and development personnel (both hardware and software) in the areas of process control and word processing. Opinion has been expressed, however, that most of that effort will be technically sophisticated, will largely be concentrated at the manufacturer level, and will not evolve into a major manpower requirement.

Do you basically agree with the opinion in the above paragraph? (Check one): ____ Yes ____ No. If you checked "No", please indicate why:

_____

_____

_____

_____

_____

_____

_____

Sophisticated process control systems in robotics applications will require some numerical control changes when the system is moved from one application to another. However, these numerical control operations probably will require only simple re-direction of mechanical movements, not computer services personnel such as programmers or analysts.

Do you basically agree with the statements made in the above paragraph? (Check one) ____ Yes ____ No. If you checked "No", please state why:

_____

_____

_____

_____

_____

_____

We therefore suggest that there will be relatively little demand for traditional computer personnel in the process control and word processing functional areas, with the exceptions of personnel in the data entry and data control areas.

Do you basically agree with the statement in the above paragraph? (Check one) ____ Yes ____ No. If you checked "No", please indicate why:

_____

_____

_____

_____

_____

_____

There appear, however, to be a number of microchip-related changes in the data processing functional area which have strong implications for computer services personnel. Some of these are:

- reduction in computing cost;
- more applications packages;
- growing user sophistication;
- more experimentation;
- easier machine diagnosis maintenance.

These factors, along with others, may influence the number and mix of computer professionals.

Below we offer three statements, A, B, and C, which we then will ask you to rank-order depending on your estimate of the likelihood of occurrence.

A. Because of the number of pre-programmed packages available in the future, the total demand for full-time programmers and analysts will decrease.

B. As micro and mini computers become more commonplace, analysts and programmers will more and more decentralize, moving to user locations. The total demand for these professionals will not change, just their location.

C. Other opinion suggests that as users become more accustomed to obtaining low-cost information, appetites for even more information will grow. This situation will result in an increase in the total demand for full-time computer professionals.

Please indicate below your estimate of the likelihood of these scenarios occurring. Rank as 1, 2, or 3, as follows:

1 = Most Likely
2 = Second Most Likely
3 = Least Likely

Rank Below

___ A. Greater Total Demand

___ B. The Same Total Demand

___ C. Smaller Total Demand

Any comments?

One possible consequence of microchip technology is that not only may the number and mix of computer professionals change, but also the types of computer personnel may be affected. Functional specialists such as accountants or business analysts who spend some time in their functional speciality, and some time modifying and running applications software, or "firmware", may become commonplace.

Do you agree with the statements made in the above paragraph? (Check one) ____ Yes ____ No. If you checked "No", please state why:

_____

_____

_____

_____

_____

_____

Based on your answers above, we would like you to indicate more specifically your expectations of future computer services personnel requirements.

On the next page, please check one item for each type of professional listed based on your expectation how demand for that category will change by 1986.

DEMAND FOR COMPUTER SERVICES
PERSONNEL IN 1986 COMPARED TO THE PRESENT

As a guide, the following levels should be used for your responses:

"Far Fewer" ..... Less than half as many

"Fewer" ..... Down to half as many

"The Same" ..... About the same number

"More" ..... Up to twice as many

"Far More" ..... Over twice as many

	Personnel Position	Expected Demand				
		Far Fewer	Fewer	The Same	More	Far More
1.	Systems Analyst	____	____	____	____	____
2.	Programmer	____	____	____	____	____
3.	Systems Software Programmer	____	____	____	____	____
4.	Computer Operator	____	____	____	____	____
5.	Functional Specialist/ Operator *	____	____	____	____	____
6.	Maintenance Personnel	____	____	____	____	____
7.	Data Entry/Data Control Clerks	____	____	____	____	____
8.	Any other new or emerging personnel types?					
	_____					
	_____					
	_____	____	____	____	____	____

* This position implies that the person is a functional specialist; e.g., a business analyst, who spends part of his time operating (Programming, operating, etc.) computer as an adjunct to his normal activities.

We would appreciate any further comments below describing any other important changes you see taking place which we have not addressed:

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